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A Human Factors Assessment of the Maneuver Command and Control (MC2) Interface at Company Level and Below

by Bruce S. Sterling and Cheryl A. Burns

ARL-TR-3364 November 2004

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14. ABSTRACT

Research for the November 2003 Unit of Action Developmental Experiment 1, which was conducted by the Human Research and Engineering Directorate of the U.S. Army Research Laboratory, had three objectives. The first was to assess the level of functionality of the maneuver command and control (MC2) system as a C2 interface at company level and below. The second was to determine operator situational awareness (SA) and workload levels. The third objective was to examine aspects of the interface design, such as visual display, to determine if the Soldier-machine interface was satisfactory. The MC2 was subjectively rated by users at company level and below as performing poorly on many key functions necessary for C2 in an automated manner and in assisting users in performing these functions. These functions included maintain SA; access relevant information; collaboratively develop plans; develop operations orders (OPORDs) and create graphics; distribute OPORDs and graphics; rehearse the plan; maneuver forces; call for fires; control fires; notice changes in the situation in a timely manner; and respond to changes in a timely manner. This could be a result of the limited training (three days) that the personnel received but also reflects the need to improve interface design. Given the results noted here, it is no surprise that the SA of MC2 users was insufficient with a mean rating of 6 (insufficient; not aware of all the information required to perform the task) on a scale of 10 (higher numbers = higher SA) for all trials. However, even though the interface did not help users much on critical functions, workload was rated moderate with a mean of 5 (reduced spare capacity on a scale of 10 (higher numbers = higher workload) for all tasks. This was probably because some units were not "in the fight" during most of the time in the scenario but were waiting for the situation to develop. Concerning interface design, most aspects of the visual display interface were seen as borderline, which suggests difficulties in Soldiers' seeing objects on the screen. Concerning software functionality, intuitiveness was evenly divided between borderline and poor; feedback was generally seen as poor, while usability was again divided between borderline and poor. Maps and graphics were generally rated borderline to poor with overlays rated most positively. Concerning information management, sending messages was rated mostly borderline, while maintenance was rated mostly as poor. Many aspects of the interface were only occasionally used. Only OPORDs and graphics were used consistently. However, most aspects were rated as borderline to poor in ease of use, which may account for why they were not used more frequently. Results are discussed in terms of subject matter expert and participant observations, suggesting reasons for the low ratings, and highlighting those aspects of the interface that users would like to see improved. Recommendations are made concerning changes in the MC2 that would improve SA, facilitate the development of OPORDs and rehearse the plan collaboratively, simplify calls for fire and controlling fires, and enhance interface design.

15. SUBJECT TERMS

battle command; command and control interface; common operational picture; maneuver command and control

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Contents

List of Figures

List of Tables

1. Introduction

1.1 Overview

Research conducted by the Human Research and Engineering Directorate of the U.S. Army Research Laboratory for the Unit of Action Developmental Experiment (UADEV) 1 had three objectives in assessing the surrogate battle command system interface (maneuver command and control) for future force use:

1. Assess command and control (C2) functionality,
2. Determine operator SA and workload levels, and
3. Assess interface design.

A brief overview of the experiment is presented, followed by a description of the experimental method. Results are then given for each of the three objectives, followed by a summary and explanation of the results and recommendations.

1.2 Experiment

The UADEV 1 was conducted from 10 to 20 November 2003 at the Unit of Action Battle Laboratory's (UAMBL) mounted warfare test bed at Fort Knox, Kentucky. The purpose of the UADEV 1 was to examine networked battle command at the company level and below and refine the operational requirements document for the future C2 system (U.S. Army Armor School and Center, 2003).

The experiment was based on the future combat system organizational and operational concept (Department of the Army, 2003) and involved a C2 cell for one combined arms battalion (CAB), with five maneuver company teams that consisted of a reconnaissance, surveillance, and target acquisition (RSTA) company, two infantry companies, and two mounted combat system (MCS) companies. The RSTA company and one MCS company had subordinate platoons, while the other three companies were represented by a company commander, with platoons controlled by research assistants. An aviation squadron, non-line-of-sight (NLOS) battalion, and a mortar battery were "played" as a constructive simulation[1]. The unit of action (UA) and opposing forces (OPFOR) were represented by a "white cell[2]" which served as higher headquarters for the CAB and controlled the OPFOR.

The experiment was preceded by three days of training. The first day consisted of individual through company-level training, and the final two days were devoted to training as a CAB. A

[1] In constructive simulation, an entire unit (such as a company or battalion) is controlled by one person, versus having crews in each vehicle as in virtual simulation.

[2] A white cell consists of personnel who role played higher headquarters in the simulation.

two-day pilot test was run, followed by six days of experimental runs, with three days for each of two trials. The pilot test primarily involved movement from the assembly area, with little enemy contact. The first experimental trial involved an attack in open terrain with an infantry platoon attached to the MCS company, while the second experimental trial was an attack in urban terrain.

The simulation was relatively stable over the experiment, with relatively few "crashes" or problems with system integration. There were some lags in the revisions of the common operational picture (COP), but these were not so severe or common as to disrupt the experiment.

2. Method

2.1 Participants

Participants were 19 personnel with current or previous active duty experience, who role played company commanders, platoon leaders, and squad leaders. Data were collected through surveys from the following leadership positions: five company-level leaders (commanders or executive officer); four platoon-level leaders (platoon leaders or platoon sergeant]); and five squad-level leaders (squad leaders or robotics non-commissioned officer [NCO]). Not all respondents answered the item concerning position, and not all participants answered all other survey items.

2.2 Instruments

The survey was the primary instrument for this experiment and contained of six types of questions. The first type of question was to determine which functions the maneuver command and control (MC2) could perform automatically. The second type of question was to determine how well the MC2 interface assisted with tasks that could not be fully automated. The third type asked participants to rate their situational awareness (SA) and workload to perform certain tasks during the trials. The fourth type of question examined interface design (e.g., visual display, intuitiveness of design). The fifth and sixth types of questions examined frequency and ease of use of key functions.

2.3 Procedure

Surveys were administered to each participant three times: after the pilot test, trial 1 and trial 2. The surveys were on line and respondents completed the surveys after they completed the trials. For each question, responses were tabulated for each of three runs and overall (all three runs combined). A total of 36 to 40 responses per question was collected; 17 to 19 respondents answered questions concerning the pilot, 13 to 15 answered questions about the first trial run, and six answered questions about the second trial run.

2.4 Analyses

Because of the small number of respondents and the repeated surveys, only descriptive statistics were used. Except for objective 1 (tasks that could be automated), responses were analyzed by trial and totaled over all trials to provide an overall view of the results. For objective 1, only overall results were provided. It was determined that breaking responses into three categories (automated tasks, tasks that the interface assists in performing, tasks that the interface cannot perform) and then three trials would result in an insufficient number of responses per cell to provide for an effective interpretation. The figures in the main body of the report present overall data only. The tables in appendix A present data from all three trials as well as overall data.

The following conventions are used in discussing the figures. If 75% or more of the responses were in the top two categories (e.g., good or very good; easy or very easy; often or always) of the five-point scale, the item was considered "good" or "used". If 50% to less than 75% of the responses were in the top two categories, the item was considered "borderline". If less than 50% of the responses were in the top two categories, the item was considered "poor" or "not used".

3. Results

3.1 Overall Summary

Results address three objectives: automation of functions, workload and SA, and interface design.

The only functions that respondents agreed could be automated were identification of type and strength of friendly units. Respondents also rated the interface as poor in performing many functions that required user input (i.e., functions that could not be automated), such as maintain SA and control fires. While some of these ratings could be attributed to lack of training (only three days), it was apparent that interface design needed to be improved as well.

SA was insufficient (since the interface could not perform many key functions well, the insufficient SA is not surprising), and workload was seen as relatively low (which could have resulted from the pace of the scenario).

Most ratings for interface design were borderline to poor. Maps and overlays were the only features used frequently. Most interface features were rated as borderline to poor in ease of use, which may account for their infrequent use. The simulated command, control, communications, and computer (SC4) interface was generally used more than the MC2 interface, particularly in the urban fight.

User comments derived from the data analysis are used to identify specific improvements needed in the MC2.

3.2 Automation of Functions and Assistance With Key Tasks (Objective 1)

This objective was divided into two parts:

1. Assess function automation, and
2. Assess functions that could assist in key tasks.

There was no clear consensus whether the MC2 could perform key functions automatically, with operator assistance, or at all. Most respondents indicated that the MC2 could automatically identify type and strength of friendly units. MC2 is designed similarly to Force XXI battle command brigade and below (FBCB2) in that location and composition (type and strength) of all friendly units in the network are automatically and continuously reported. Also, most stated that the MC2 could assist the operator in identifying enemy strength and civilian strength, as well as projecting future location of friendly units. That is, the interface could not actually do these functions but could provide information to the user so that the user could perform the task. There were no functions that most respondents felt the interface could not perform.

3.2.1 Automation of Functions

Before the experiment, 16 functions were identified as being possible to fully automate (i.e., could be automatically performed by the interface without user input) at the company level and below. Soldiers were asked to assess if the MC2 could perform these functions automatically. If it could not, Soldiers were to assess whether the MC2 could assist them (with some user input) in performing those functions or if the interface was unable to perform the function at all.

Figure 1 shows ratings of automation of current operations tasks. For two tasks (identify friendly unit type and strength), a bare majority indicated that the tasks can be automated. MC2 is designed similarly to Force XXI FBCB2 in that location and composition (i.e., type and strength) of all friendly units in the network are automatically and continuously reported. Also, most respondents stated that MC2 could assist them in identifying enemy strength and strength of civilians on the battlefield.

Figure 2 shows ratings of automation of future operations tasks. Most respondents agreed that the MC2 could assist users in projecting future locations of friendly units. This is a key element of assessing the progress of the current plan.

Figure 3 shows ratings of automation of terrain analysis tasks. There is no clear consensus concerning whether the MC2 can perform these tasks automatically, assist the user, or not perform them at all. It seems desirable that identifying types of terrain and their effects on friendly maneuver should be automated.

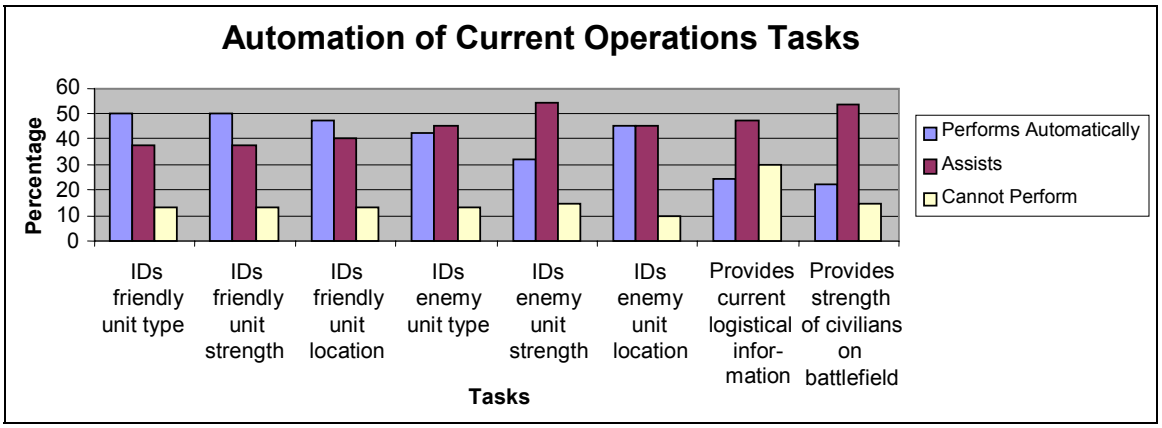

Figure 1. Automation of current operations tasks.

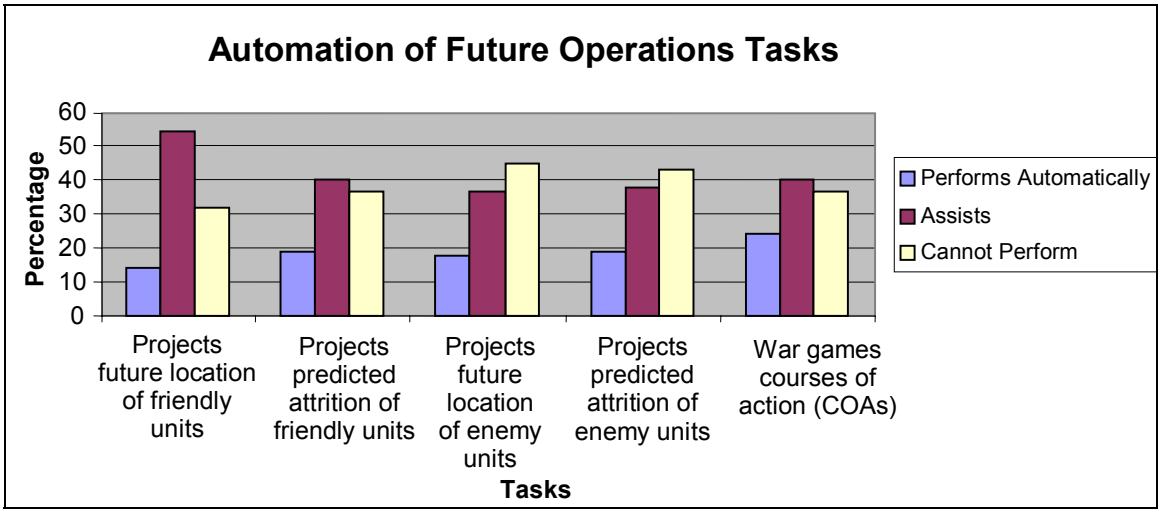

Figure 2. Automation of future operations tasks.

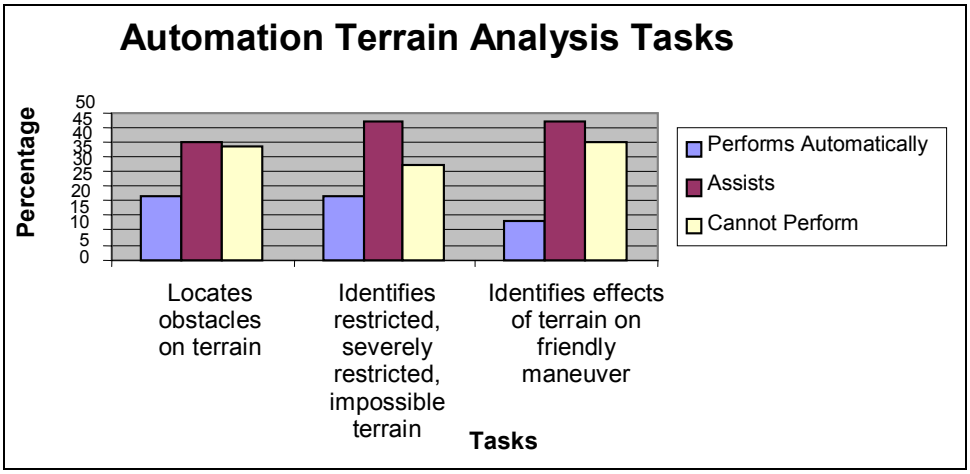

Figure 3. Automation of terrain analysis tasks.

3.2.2 Assistance With Key Task Performance

Eleven high-level tasks (e.g., maintain SA) critical to battle command, which the MC2 could assist the Soldier in performing, were identified with input from UAMBL personnel before the experiment. Results in figure 4 show that no tasks were rated positively by most overall respondents. Since operators only received a few days of training, it could be that with more training, the ratings would have improved. However, it is likely that improvements in interface design are needed as well.

Only for one trial (trial 2) did half or more of respondents rate the performance of the MC2 as good or very good on all tasks (see appendix A, table A-1). Since this was the last trial, the results may represent some improvement as a result of experience. However, because of the smaller number of respondents, this information may be suspect. The pilot results showed that exactly half rated the MC2 as good or very good in developing operation orders (OPORDs) and graphics (see appendix A, table A-1).

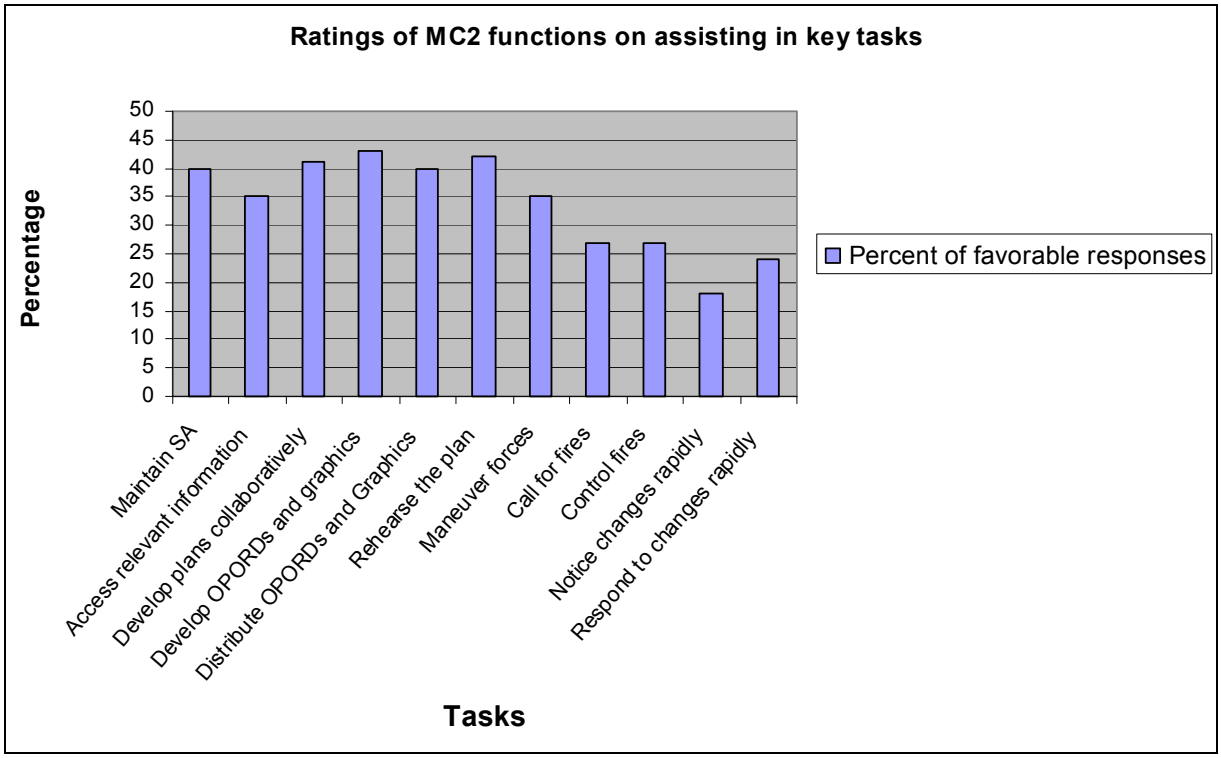

Figure 4. Ratings of MC2 functions on assisting in key tasks.

3.3 Situational Awareness and Workload Using the MC2 (Objective 2)

SA and workload were rated on 10-point behaviorally anchored scales (see appendix B). Results indicated that SA was insufficient and did not vary substantially over trials. SA was slightly lower in the third trial, perhaps reflecting the inherent difficulty of maintaining SA in urban combat (see appendix A, table A-2). Workload was relatively low throughout and even lower in

the last trial (see appendix A, table A-2). This may be a result of learning, but it is based on a small number of observations.

3.3.1 Situational Awareness

As shown in figure 5, SA was insufficient. Given the ratings of the ability of the interface to perform key C2 functions, it is not surprising that the interface did not provide good SA. The simulation itself was relatively stable over the experiment, so the rating of SA is unlikely to be attributed to problems with the simulation itself.

Appendix A, table A-2 shows SA ratings for all trials. The SA was rated approximately 6 (insufficient-not aware of all the information required to perform the task) on a scale of 10 (higher numbers = higher SA) for all trials. The SA for trial 3 was slightly lower than for other trials, although ratings of effectiveness of MC2 were higher for that mission. Based on these results, it appears that the MC2 did not provide sufficient SA.

3.3.2 Workload

As indicated in figure 5, workload was relatively low. This may reflect a lack of activity during the trial while we were waiting for events to develop. Overall, workload was 5 (spare capacity was reduced) on a scale of 10 (higher numbers = higher workload) for all tasks. The workload to plan missions appeared to be slightly lower than the workload for the other three tasks, which suggests that not much planning was performed (or that planning is not as cognitively complex as execution or task management).

Workload for all trials is shown in appendix A, table A-2. Workload for trial 3 was slightly lower than workload for the other trials, except for workload to plan a mission. This may reflect more experience with the interface but is based on a small number of respondents.

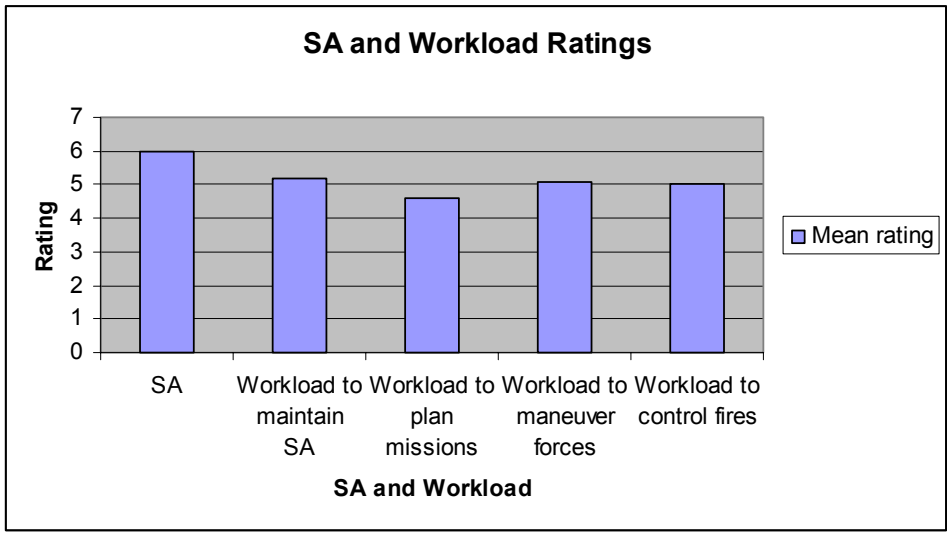

Figure 5. SA and workload ratings.

3.4 MC2 Interface Design (Objective 3)

Interface design is divided into four areas: visual display, software functionality, maps and graphics, and information management. Most aspects of the visual display were seen as borderline, which suggests that Soldiers were having some difficulties in seeing objects on the monitor. Concerning software functionality, intuitiveness was evenly divided between borderline and poor; feedback was generally seen as poor, while usability was again divided between borderline and poor. Maps and graphics were generally rated borderline to poor with overlays rated most positively. Concerning information management, sending and receiving messages was rated mostly borderline, while maintenance was rated mostly as poor. In addition, interface design addressed the frequency and ease of use of different MC2 features. Many aspects of the interface (other than maps and overlays) were not frequently used. Many aspects were rated as difficult to use, which may partially account for the fact that they were not used.

3.4.1 Visual Display

Most aspects of the visual display are seen as borderline (50% to less than 75% of favorable responses). Figure 6 shows assessment of various visual display aspects. Only contrast, field of view, and finding the cursor (38% of the items) were rated good (75% or more favorable responses) overall. All other ratings of the visual aspects of the interface (62%) were borderline, which indicates that improvements could be made in the display. Many of the borderline ratings seem to concern intensity, sharpness, and general resolution, thus suggesting that Soldiers were having difficulty in seeing objects on the monitor.

As shown in appendix A, table A-3, ratings of the pilot test (the least challenging) were the most positive.

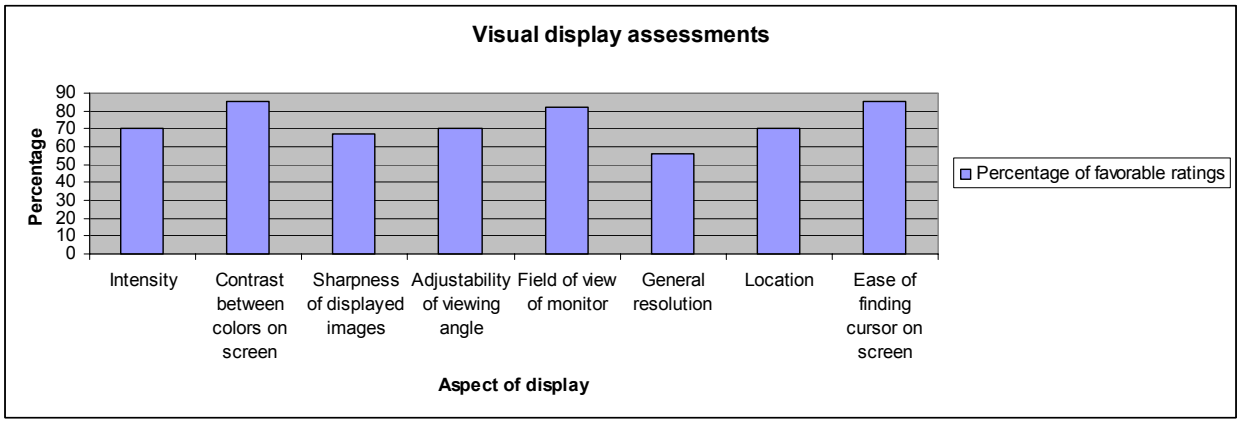

Figure 6. Visual display assessments.

3.4.2 Software Functionality

Software functionality was assessed in three categories: intuitiveness, feedback, and usability. Intuitiveness was evenly divided between borderline and poor. Feedback was generally seen as poor, while usability was again divided between borderline and poor.

3.4.2.1 Intuitiveness

As shown in figure 7, the items were divided evenly between borderline and poor (less than 50% favorable responses), which indicates that improvement is needed in making the software more intuitive; even the borderline areas were in the low end of the scale (50s and 60s). The areas of finding needed information, consistency from one application to another, and intuitiveness of abbreviations, codes, and acronyms were rated particularly low.

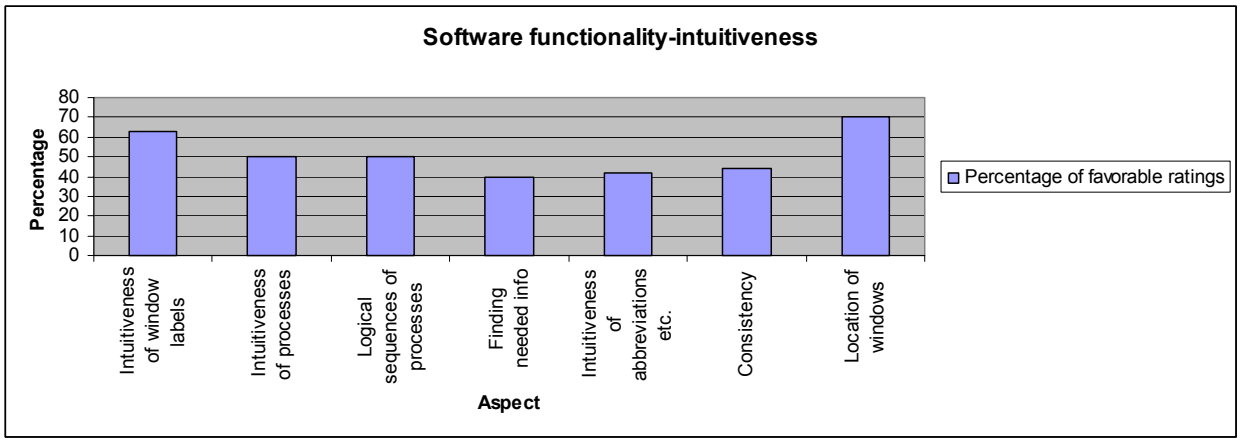

Figure 7. Software functionality-intuitiveness.

3.4.2.2 Software Feedback

As shown in figure 8, nearly all aspects (81%) were rated poor. Problems appeared to center in the areas of error avoidance or correction, alerts concerning incoming information, or navigating the interface. This is an area that particularly needs improvement.

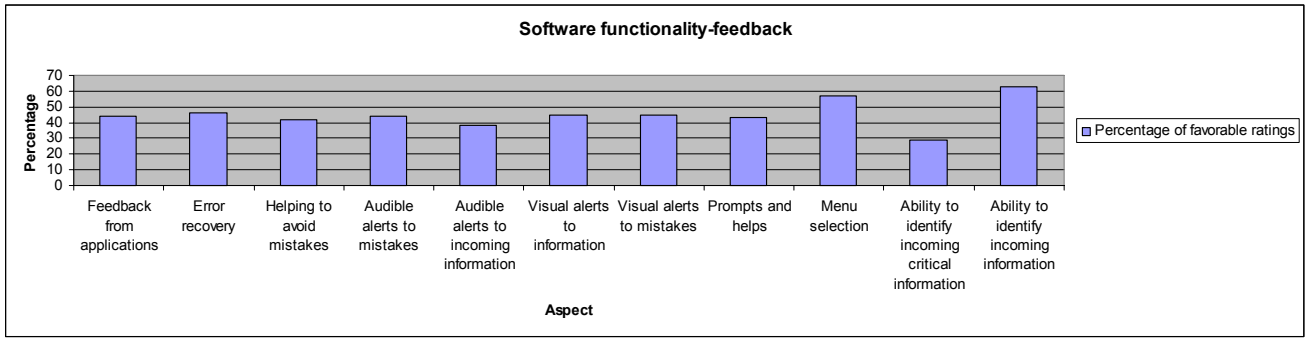

Figure 8. Software functionality-feedback.

3.4.2.3 Usability

As shown in figure 9, ratings were divided between borderline (60% of items) and (40%) poor. Significantly, overall user friendliness was rated as poor.

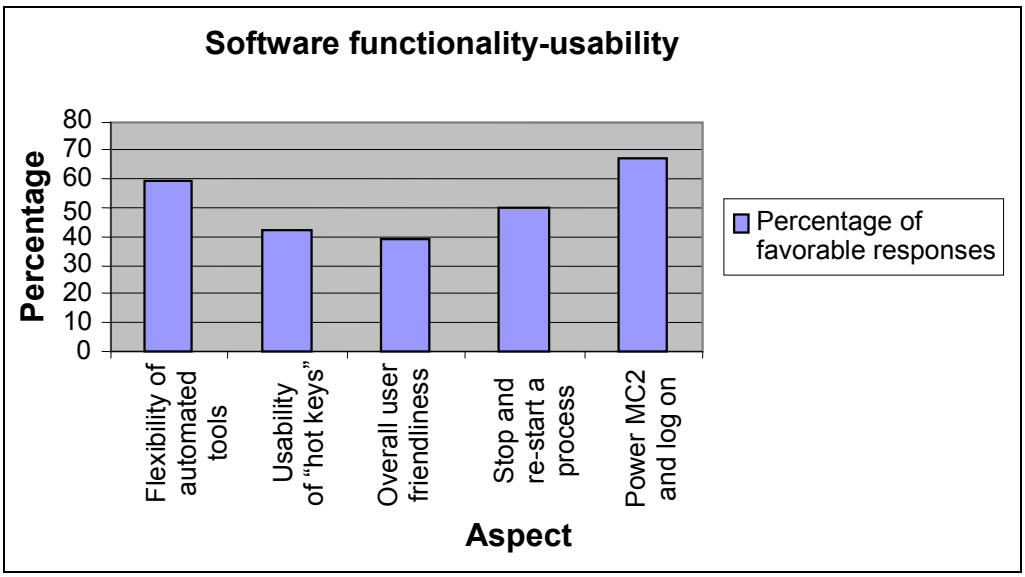

Figure 9. Software functionality-usability.

As shown in appendix A, table A-4, over all areas, the pilot test (least challenging) had the highest ratings, whereas the first experimental trial had the worst ratings. This could represent the contrast between the easy run and the first more demanding trial.

3.4.3 Maps and Graphics

Maps and graphics were assessed in four categories: maps, overlays, symbology, and other functions. In general, these aspects were rated borderline to poor, with overlays rated most positively.

3.4.3.1 Maps

As shown in figure 10, maps were rated as borderline (67% of the items) to poor (33%). Performing terrain analysis was seen as particularly poor, which corresponded to user comments.

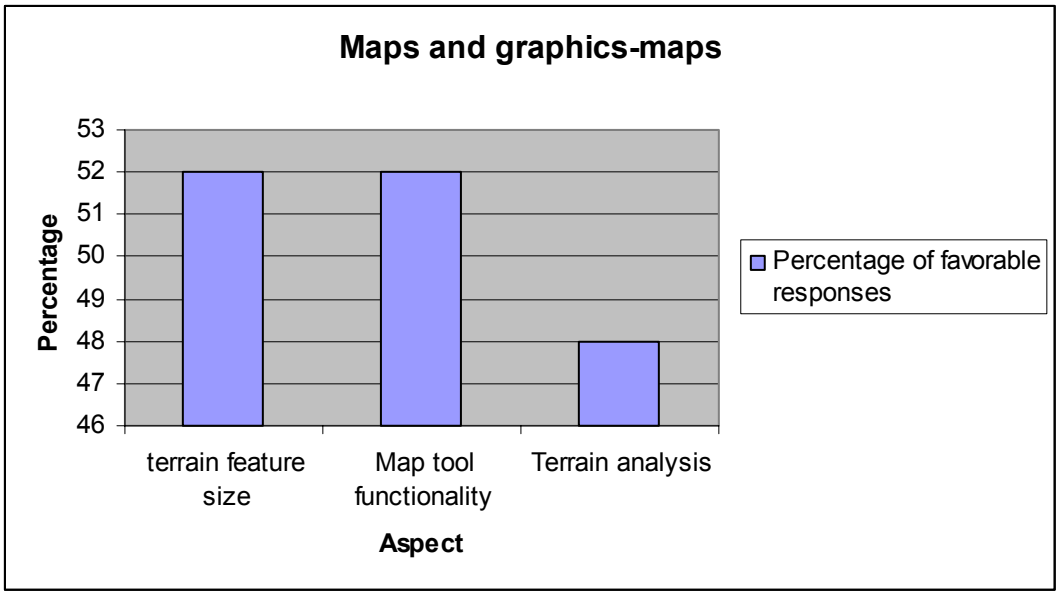

Figure 10. Maps and graphics-maps.

3.4.3.2 Overlays

As shown in figure 11, overlays were rated as borderline (83% of the items) to good (17%). The capability of saving an overlay was seen as especially good.

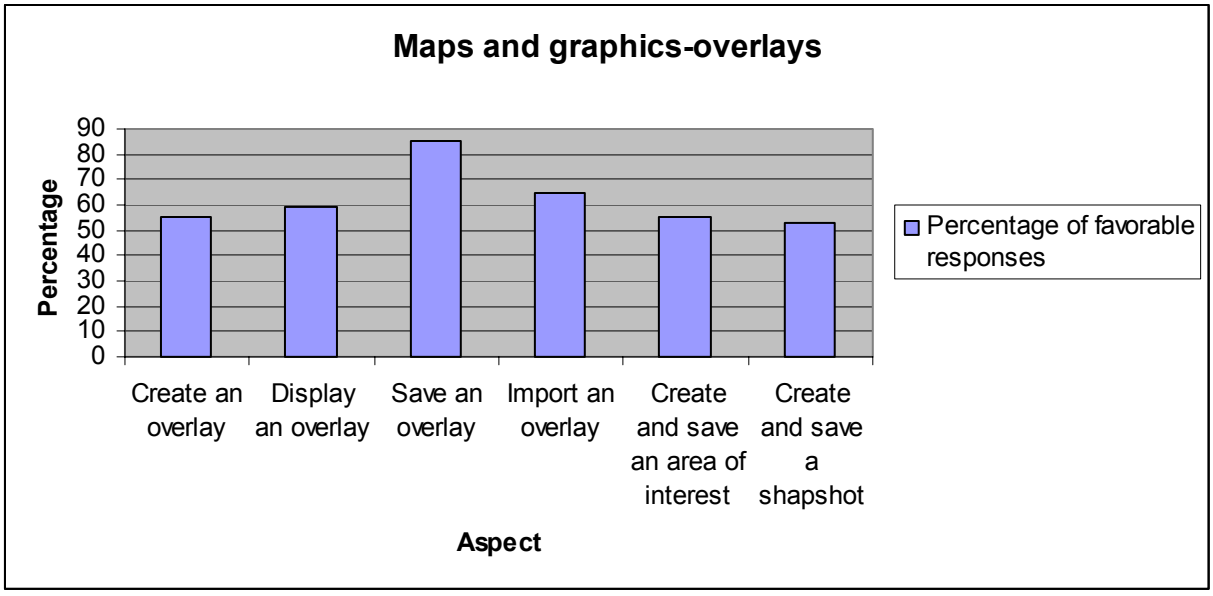

Figure 11. Maps and graphics-overlays.

3.4.3.3 Symbology

As shown in figure 12, symbology was rated as borderline (67% of the items) to poor (33%). Non-combatant symbols, unit boundaries, and making changes in units (command relationships) were seen as especially poor. The non-combatant symbols were as large as unit symbols, which could have led to their negative ratings. Users commented that they would like units to be color coded to indicate identity or ownership. If it existed in this version, it was not taught.

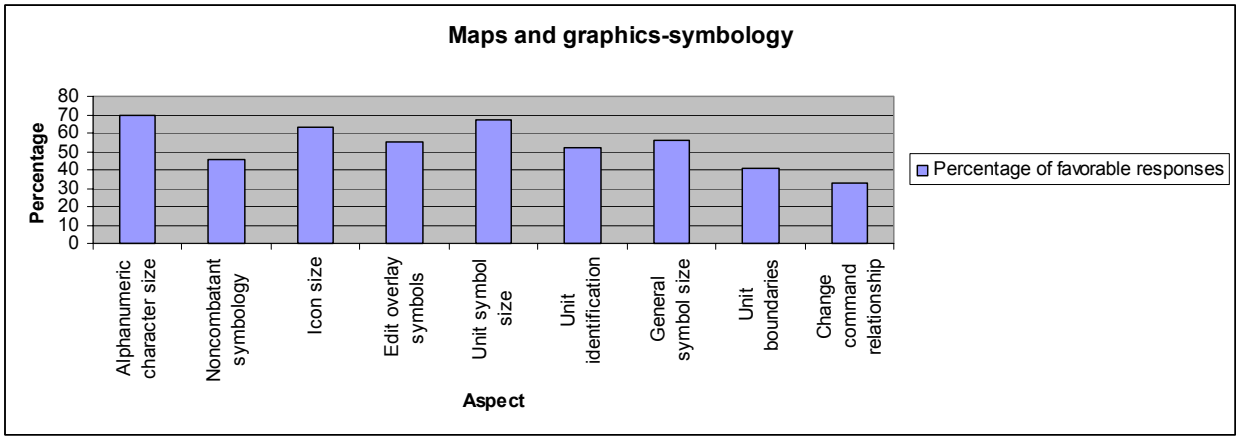

Figure 12. Maps and graphics-symbology.

3.4.3.4 Other

Under the "other" category, the animation tool (used for planning) was rated barely borderline, while "whiteboards[3]" were rated poor (see figure 13). Generally, effective standing operating procedures (SOPs) must be established before members can be joined to a whiteboard conference without "crashing" the system.

Ratings of maps and graphics for all trials are shown in appendix A, table A-5. Again, as with other ratings, the pilot test generally had the most positive ratings, with the first trial receiving the most negative.

[3]A whiteboard is software that enables personnel in separate locations to conduct collaborative planning. In a collaborative session, using the same operational graphics, participants can draw proposed routes, etc., on their computer screens, and all others in the whiteboard conference can see them. Audio communication by radio is also available to all participants.

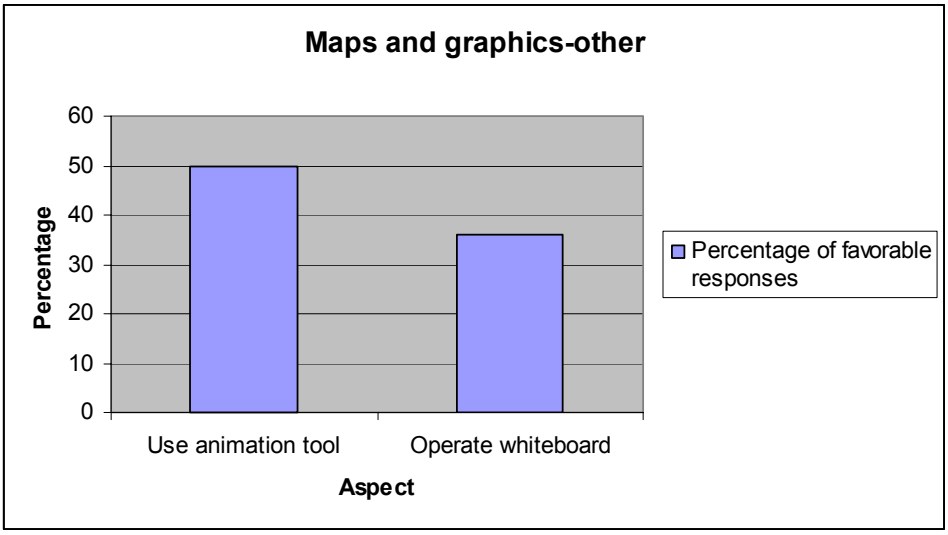

Figure 13. Maps and graphics-other.

3.4.4 Information Management

Information management was divided into sending/receiving messages and maintenance. Sending/receiving messages was typically rated as borderline, while maintenance was rated mostly as poor.

3.4.4.1 Sending Messages

As shown in figure 14, sending/receiving messages was rated as borderline for 80% of the items, while 20% were rated as poor. Distributing outgoing information was rated as poor, which corresponded to user comments about transmitting OPORDs and graphics.

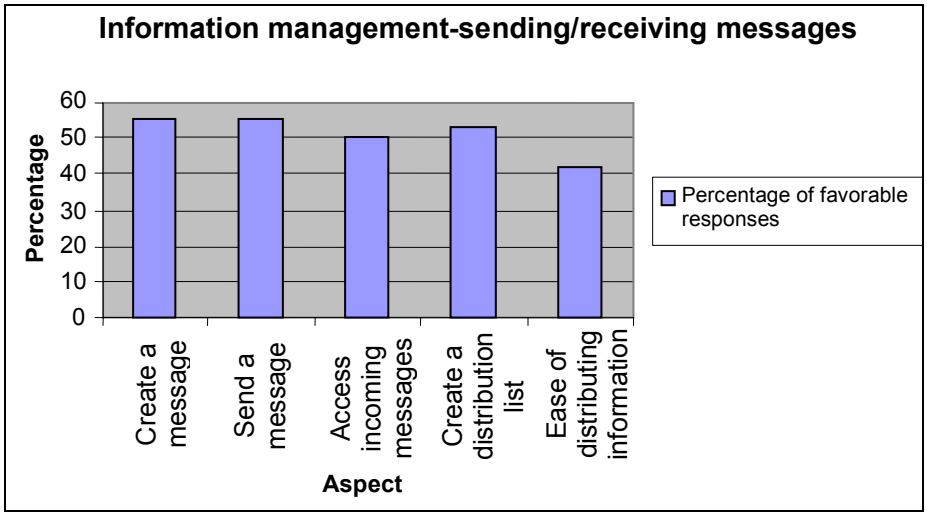

Figure 14. Information management-sending/receiving messages.

3.4.4.2 Maintenance

As shown in figure 15, maintenance was generally rated as poor (83% of the items, with 17% as borderline). Only copying and moving files were rated as borderline. All other aspects of file or database management were rated as poor. This is another area that needs improvement.

Ratings for information management on all trials are shown in appendix A, table A-6. Again, the pilot test received the most positive ratings and the first trial received the most negative.

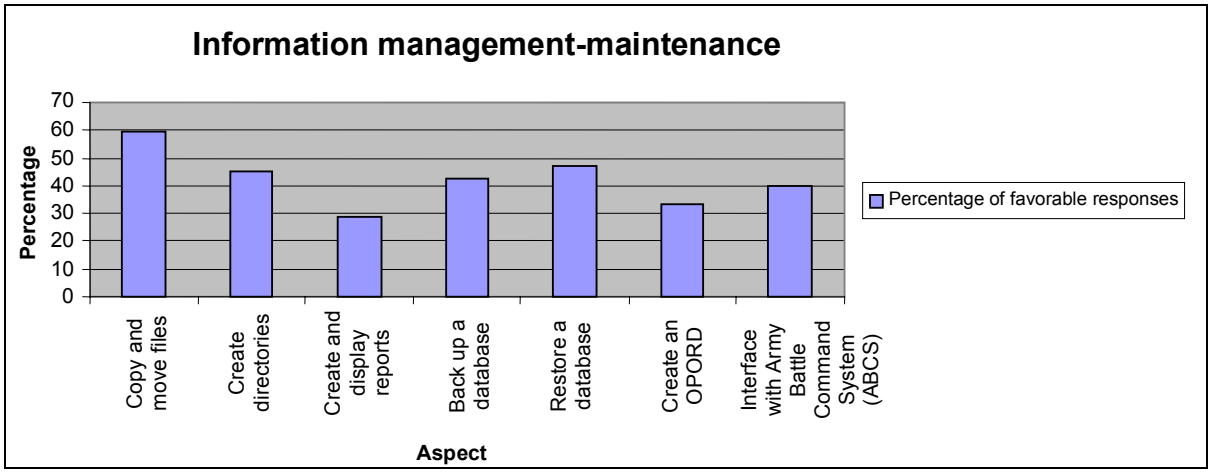

Figure 15. Information management-maintenance.

3.4.5 Frequency and Ease of use of Functions and Application

Frequency and ease of use of functions and applications are divided into three categories: maps and graphics, information management, and C2 functions. Because of transcription errors between the survey submitted and the survey placed on the web browser, frequency questions were not asked for all the same items as were ease of use questions, leading to some of the data being missing. Overall, the only features that were reported used with any frequency were maps and overlays. Ease of use was rated from borderline to poor for most items, with maps and graphics having the most favorable rating.

3.4.5.1 Maps and Graphics

Figure 16 shows that these were rated as not used except for maps and overlays (17% of the items). In the after-action reviews, the ability to construct and transmit graphic control measures was one aspect of the C2 interface cited as critical. Maps and overlays were the only functions used often or always by half or more respondents overall.

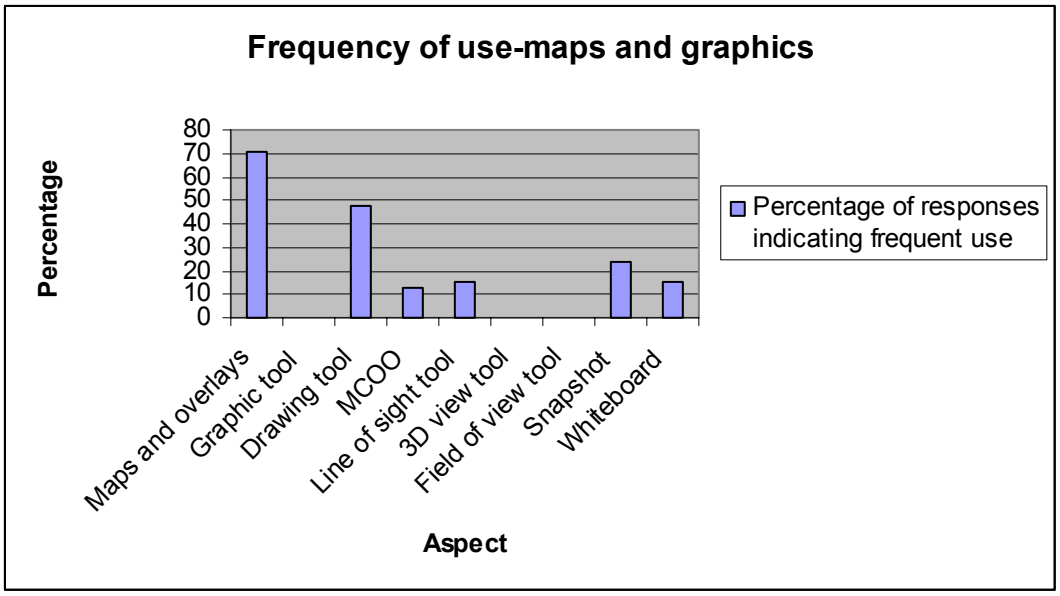

Figure 16. Frequency of use-maps and graphics.

Figure 17 shows that maps and overlays were rated borderline along with most maps and graphics tools (78%). Only the modified combined obstacle overlay (MCOO) and whiteboard were rated as poor. As stated earlier, the whiteboard was difficult without a good SOP. Good SOPs were developed for use in other experiments.

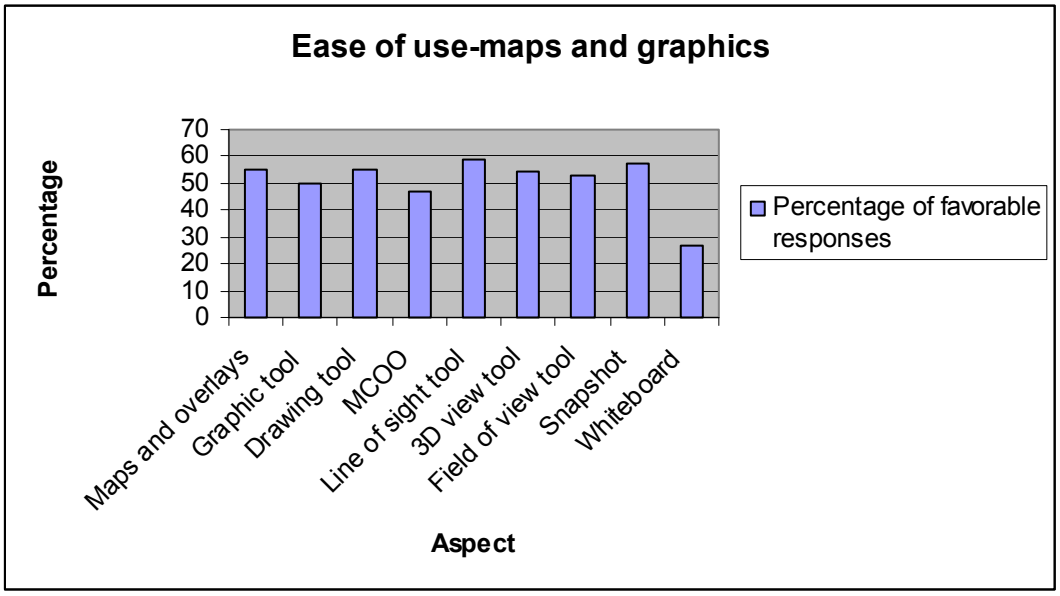

Figure 17. Ease of use maps and graphics.

3.4.5.2 Information Management

As shown in figure 18, these features were rarely used, possibly because Soldiers were not trained.

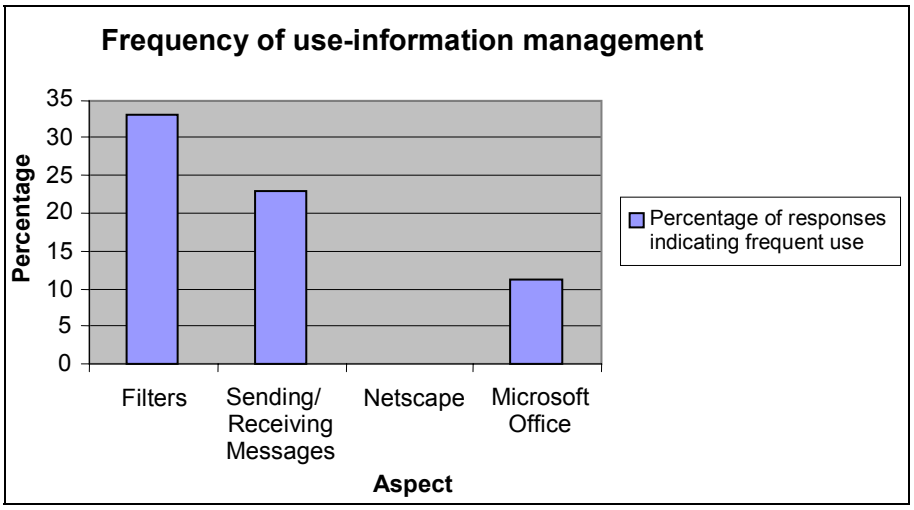

Figure 18. Frequency of use-information management.

Figure 19 shows that ease of use for information management tools was rated as borderline (50% of items) to poor (50% of items). Surprisingly, Netscape[4] and Office[5] were rated poor in the ease of use, perhaps reflecting the ease of accessing these features from MC2 or integration of these features with MC2. Although demographic data about the participants were not available, many users had participated in other UAMBL experiments and had seemed reasonably computer literate.

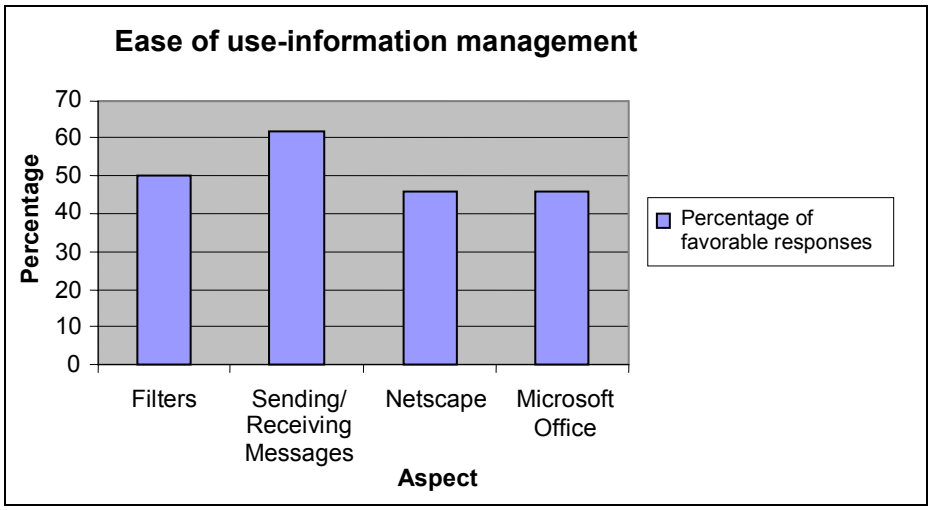

Figure 19. Ease of use-information management.

[4] Netscape® is a registered trademark of Netscape.

[5] Office™ is a trademark of Microsoft Corp.

3.4.6 Command and Control

Figure 20 shows that these functions were rarely used. Perhaps most of these functions were not used because participants saw no need for these tools at company level and below or there was a lack of training.

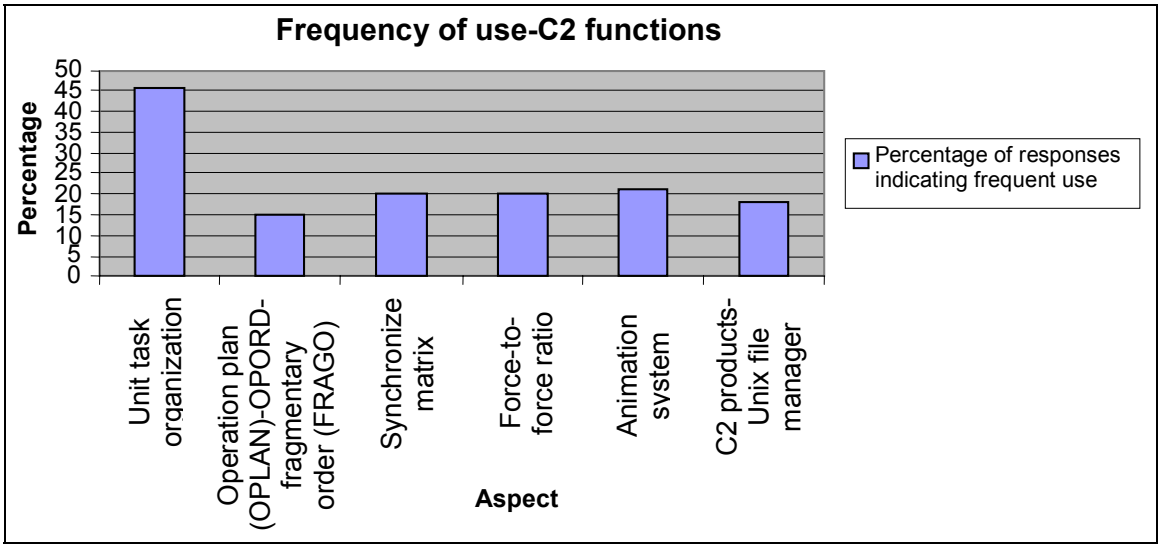

Figure 20. Frequency of use-C2 functions.

However, figure 21 shows that their ease of use was rated borderline (67% of items) to poor (33%), especially OPORDs and synchronization matrices.

Frequency and ease of use ratings for all trials are reported in appendix A, table A-7. Frequency of use was relatively uniformly low over all trials, but ease of use was again rated highest on trial 2. Again, this may reflect a learning curve or be an artifact of the small number of respondents.

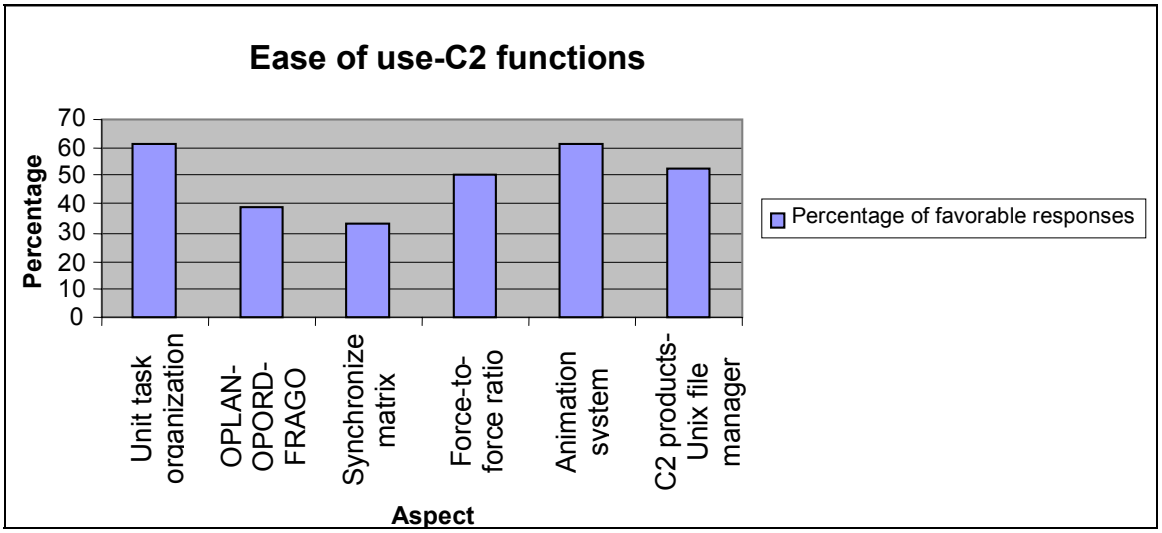

Figure 21. Ease of use-C2 functions.

3.4.7 Use of MC2 and SC4

Figure 22 shows use of the MC2 versus the SC4 interface. The SC4 is another battle command interface developed by UAMBL, which was also available to the users. The SC4 had higher usage than the MC2 in both trials, thus suggesting that this is the C2 system of choice for more demanding trials. Standard deviations for both systems were comparable (34.3 for SC4 and 31.5 for MC2). Comments indicated that the SC4 had a better digital map, which was especially critical in the urban vignette (trial 2). Furthermore, the SC4 was more comparable to the 3-D (out of "vision blocks") imagery seen from simulated vehicles. Both systems were used more on trial 2, which could suggest that C2 systems are particularly important in urban operations.

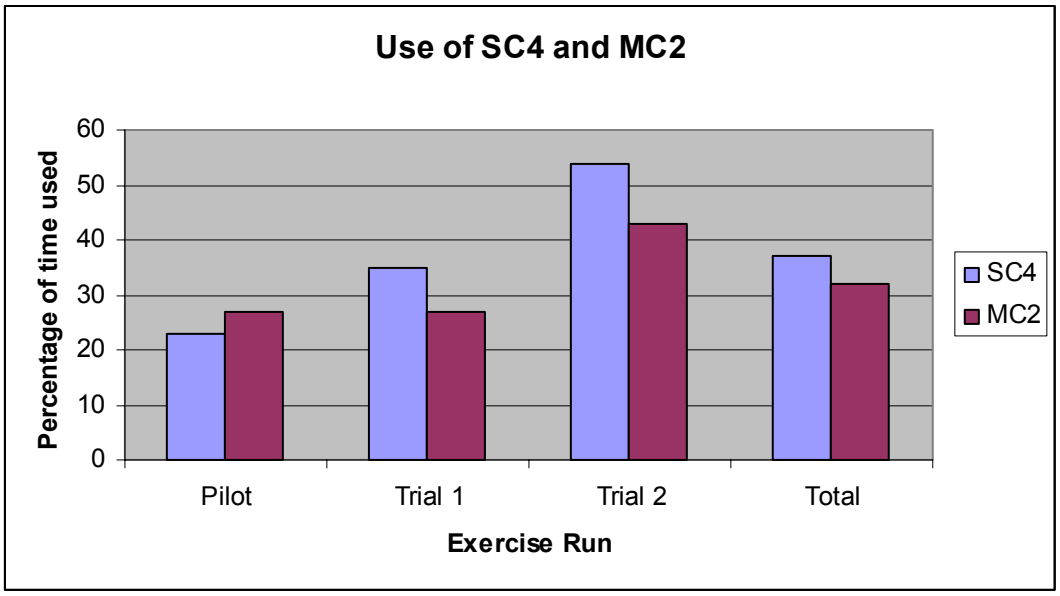

Figure 22. Use of SC4 and MC2.

3.4.8 Information From After-Action Reviews

The ability to quickly and easily create and send overlays with graphic control measures was the most commonly requested feature. In order to develop graphic control measures, users requested a template of pre-formatted graphics, as well as the ability to easily initiate a collaborative session and draw with a "Madden pen"[6]. A separate window (or monitor) for collaboration was also desired. These remarks match survey findings that maps and overlays and drawing tools for maps and overlays were the only tools reported used often or very often by most respondents. Other features mentioned as useful were

1. Ability to tailor the visual display (color code units with own choice of colors; have only certain units, such as platoons in your company, displayed); this may relate to the rating of difficulty of changing command relationships.

[6] provides the ability to draw on the map with the mouse

2. Ability to track logistics (fuel, ammunition, etc.).

3. Auto template of range fan of enemy weapons.

4. Unmanned aerial vehicle (UAV) footprint (range fan of UAV sensors).

5. Filters for different sensor views (i.e., entities identified by your platoon's sensors only, company's sensors, etc.).

6. Indicators of areas where current fire missions are scheduled.

7. Better target identification and battle damage assessment (BDA)—more a systems problem than an interface issue.

4. Conclusions

Results address three objectives: automation of functions, workload and SA, and interface design.

4.1 Objective 1 (automated functions)

The MC2 was rated as only performing 2 of 16 key functions automatically: identification of type and location of friendly units. Improvements are needed in terms of automated information about the enemy, terrain analysis features, logistics, and decision tools (e.g., projecting movement).

The MC2 was rated by users at company level and below as not supporting many key functions necessary for C2. These functions included maintain SA, access relevant information, develop plans collaboratively, develop OPORDs and create graphics, distribute OPORDs and graphics, rehearse the plan, maneuver forces, call for fires, control fires, notice changes in the situation in a timely manner, and respond to changes in a timely manner.

Comments from subject matter experts (SMEs) and participants can, to some extent, explain why functionality was rated poorly in these areas. The functions just listed are grouped in section 4.2 into similar clusters, and reasons gleaned from SMEs and participants that may explain these ratings are provided for each cluster.

4.2 Improve SA by Noticing and Responding to Changes in Maneuver Units While Improving Access to Relevant Information

1. The UAVs did not report the presence of enemy dismounts to either the MC2 or SC4. Thus, players were uninformed about locations and concentrations of enemy dismounts.

2. The interface should reflect the timeliness of information (i.e., how old is the information or when was the last revision).

3. The interface should incorporate an alarm system to alert the user when sensor coverage of an area is lost.

4. A "reach-back" capability to access historical and contemporary information from UA and national assets is needed.

5. Players were not able to tailor the MC2 display to their needs. For example, players were not able to color code units (e.g., one color for their company, another for other units in their battalion), set filters to display only certain units, or group or ungroup units easily. Other tools or filters requested were logistics tracking (fuel, ammunition, etc.) by specific unit; displaying range fans of enemy and friendly systems, including UAVs; a filter for what different sensors see (e.g., what my unit sensors see versus what other network sensors see); a filter for identifying enemy units; and a filter for where current fire missions are scheduled.

6. The MC2 map did a poor job of identifying urban areas. The MC2 map was simply a picture. When the "zoom in" function was used, the picture was degraded into an incomprehensible mass of shape and color (as noted in the UAMBL report). A digital map, similar to that in SC4, is needed to enhance SA in urban areas.

7. The MC2 map did not match what could be seen out of "vision blocks" of simulated vehicles.

8. There was no clear decision-making process (i.e., no decision-making tactics, techniques, and procedures [TTPs]) in the experiment. That is, with the COP, certain processes in the military decision-making process (such as developing three courses of action) seem to be obviated, but there was no established procedure about how to formulate a plan.

9. These shortcomings could be a result of the limited training given but could also reflect the need to improve the interface design.

4.3 Develop OPORDs and Rehearse Plan Collaboratively

1. The interface should include a capability to publish and disseminate orders.

2. MC2 does not enable rapid development of graphics. Instead of a template of graphic control measures that can be selected, MC2 has a series of pull-down menus, such as "type of graphics" (e.g., maneuver, intelligence), then "type of maneuver graphic" (ground or aviation), then "type of ground graphic," etc. Saving or editing overlays is also seen as being difficult.

3. Terrain analysis tools should be automated.

4. Drawing tools were also considered poor in MC2, especially compared to the SC4 tool. Also, graphics need to conform to military definitions of operational terms and symbols.

5. Training and SOPs for conferencing (collaborative planning) are necessary. A window for planning and a window for execution mode on the MC2 would also be useful. The ability to have multiple collaborative sessions is also desired by users. The capability to filter collaboration sessions (setting permissions on who is in a session) by echelon or unit was also desired.

6. Distribution of maps and overlays to all relevant participants was not easy or quick. Automated lists of who should receive overlays would be useful. This is reflected in the rating of distributing information.

4.4 Calls for Fire and Controlling Fires

1. The attack guidance matrix (AGM) in the MC2 for this experiment was rigid. When commanders did not receive requested fires, they tried to circumvent the system by requesting fires from the white cell.

2. Once a call for fire (network fires) was initiated in MC2, all visibility for that call was lost. There was no indication of whether it was approved, where it was in the queue, what delivery system it went to, or if the shot was actually made.

3. Moreover, there was no systematic plan for BDA. If a sensor saw a target after it had been shot, it revised the status of the target. BDA is more a function of unit TTPs than an interface capability, since automatic BDA is probably unrealistic. However, tools to help track enemy BDA (assuming sensor coverage) are critical. Players were reduced to using paper-and-pencil charts of destroyed enemy assets.

4.5 Objective 2 (Workload and SA)

Given the results noted, the SA of MC2 at user level was insufficient. This area received an overall rating of 6 (insufficient-not aware of all the information required to perform the task) on a scale of 10 for all trials.

However, even though the interface did little to help users in critical functions, overall workload was moderate—around 5 (spare capacity was reduced) on a scale of 10 for all tasks. One of the reasons that workload may have been perceived as low was the pace of battle. Since the experiment was a "target-rich environment," many units (e.g., the reconnaissance troop) spent much time calling for fires to reduce the threat. Since the AGM did not always supply the fires requested and BDA was poor, this slowed the pace of operations and delayed the commander's timeline.

4.6 Objective 3: (Interface design)

Overall, the visual display was rated borderline. Only aspects such as color contrast, field of view, and finding the cursor on the screen were seen as good. General screen resolution was noted as borderline. Screen clutter could account for these findings.

Software functionality was rated as borderline to poor. Aspects such as location and intuitiveness of windows were seen as borderline. Many other aspects were seen as poor, including consistency, feedback, prompts, cues to avoid or correct errors, information alerts, finding information, intuitiveness of codes and abbreviations, and overall user friendliness. Observers in the experiment noted that too much clutter and information were available on MC2. Much of the clutter covers other data and windows, making it difficult for the user to know where he or she is in the interface. Making the interface more related to the Microsoft Windows[7] operating system would help with familiarization. Additionally, more automation and information management tools to assist the user would be useful. Reducing the number of mouse clicks to accomplish functions (e.g., filter information so that only certain units are presented on the screen) is necessary. Again, the brief training may have played a role in these ratings, but improved interface design should be considered.

Concerning maps and graphics, many aspects of the visual display, such as character and icon size were seen as borderline. This version of MC2 needs a robust and customized icon option. Terrain analysis was rated as poor, which parallels the participant's comments on the need for a terrain analysis tool. The lack of ability to adjust the icon size on this version of MC2 is reflected in the poor rating of "non-combatant" symbology, which was noted as being as large as unit icons. The poor rating of unit boundaries may reflect the problems with the graphics features of this version of MC2 and lack of a Madden pen. The ability to change command relationships (assign friendly vehicles or platoons to another units) was rated as poor. Although this feature existed, it may have been taught only briefly or perceived as too difficult. The poor rating of whiteboards could be attributed to a lack of an SOP for initiating a whiteboard conference.

Overall, information management was rated as poor. This included distribution as well as maintenance aspects of creating directories, creating and displaying reports, backing up a data-base, restoring the system, creating an OPORD and interface with the Army Battle Command System. Again, a lack of ability to quickly create and send overlays, as described in participant comments and here, may account for the poor rating concerning information distribution. An interface similar to the Microsoft Windows operating system could solve many of the file management problems encountered.

Although ease of use was seen as borderline, the ability to "save overlays" was considered an easy task. Aspects such as starting the system, file management, sending/receiving messages, and tasks involving overlays were borderline. A set-up wizard would be useful to help users

[7] Windows™ is a trademark of Microsoft Corporation.

customize the interface. Important tasks such as terrain analysis, reports, OPORDs, database backup, and restoring the system after a crash were seen as difficult. As noted before, the brief training may have played a role in these ratings, but improved interface design should be considered.

Many features were not used. Of the many features available, the maps and overlays feature was the most commonly used. Furthermore, all features were rated as borderline or poor in ease of use, which may help to explain why they were not used. Those rated as poor include the operation plan, synchronization matrix, MCOO, Netscape, Office, and the whiteboard. Observers commented that there were many tools and options, but there is a need for the interface to link, compare, and fuse information across all layers of the battle command system. In discussions, again, the most frequently mentioned feature required was the ability to quickly and easily create and send overlays with graphic control measures, including obstacles (i.e., MCOO). This information was not automatically revised by the system. The unit in contact with obstacles or minefields had to make an overlay and transmit it to the rest of the unit or inform the staff so that they could construct the overlay. Participants also stated that terrain analysis (e.g., go, slow-go, and no-go terrain) should be automated.

As a final consideration, many issues were related to problems with the simulation. For example, the logistics data in the commander's portal were not being supplied by the simulation, so they could not be portrayed in MC2.

4.7 Comparison With Other Battle Command Systems

A previous report by the authors (Sterling and Burns, 2004) showed that the MC2, at least at crew and platoon levels, was rated as third in a comparison of four battle command systems. The Defense Advanced Research Projects Agency future command and control was rated the highest, the SC4 was rated as next highest, and the MC2 was rated as third best overall, with the Force XXI FBCB2 being rated as least favorable overall. The ratings of functionality at crew and platoon level were generally similar to ratings of the MC2 in this report.

5. References

Department of the Army. *The U.S. Army Objective Force Operational and Organizational Plan Maneuver Unit of Action*; TRADOC Pam 525-3-90; U.S. Army Training and Doctrine Command: Fort Monroe, VA, 2003.

Sterling, B.S.; Burns, C.A. *A Comparison of the Capabilities of Four Command and Control Systems at the Platoon Level and Below*; ARL-TN -0217; U.S. Army Research Laboratory: Aberdeen Proving Ground MD, 2004.

U.S. Army Armor School and Center. *UAMBL, Operational Requirements Document for the Future Combat Systems Change 3* (JROC Approved). Unit of Action Maneuver Battle Lab: Fort Knox, KY, 2003.

Appendix A. Data Tables

For all tables except the tables concerning workload and SA, the following shading conventions were used. If three quarters or more of the respondents answered in the top two categories (on a five-point scale), the item was considered positive (no shading), since that seems to be a general endorsement of the item. If more than half (but less than three quarters) answered in the top two categories, the item was considered borderline (grey) since a majority but not three quarters of respondents were favorable. If less than half of respondents answered in the top two categories, the item was considered poor (diagonal), since a majority did not rate it favorably. Since workload and SA had seven-point rating scales, a different shading convention was needed. Here, if the mean was in the "best" three categories (lowest three for workload and highest three for SA), the item was considered positive (no shading). If the mean was in the "middle" three categories, the item was considered borderline (grey). If the mean was in the "poorest" four categories (i.e., highest four categories for workload or lowest four categories for SA), it was considered poor (diagonal).

Table A-1. Ratings of MC2 functions on assisting in key tasks

Task	Pilot (*n*=17 to 19)	Trial 1 (*n*=15 to 15)	Trial 2 (*n*=6)	Overall (*n*=36 to 40)
Maintain Situational Awareness	**39**	**29**	**67**	**40**
Access relevant information	**22**	**39**	**67**	**35**
Develop plans collaboratively	**39**	**30**	**50**	**41**
Develop OPORDs and create graphics	**50**	**31**	**50**	**43**
Distribute OPORDs and graphics	**50**	**46**	**50**	**40**
Rehearse the plan	**47**	**23**	**67**	**42**
Maneuver forces	**29**	**36**	**50**	**35**
Call for fires	**6**	**39**	**67**	**27**
Control fires	**11**	**39**	**50**	**27**
Notice changes in the situation in a timely manner	**6**	**14**	**67**	**18**
Respond to changes in a timely manner	**17**	**14**	**67**	**24**

No fill = 75%-100% of respondents responding favorably
Grey = 50%-74% of respondents responding favorably
Diagonal = less than 50% of respondents responding favorably

Table A-2. SA and workload for operator utilizing MC2

Situational Awareness	**Pilot (*n*=17 to 19)**	**Trial 1(*n*=15 to 15)**	**Trial 2 (*n*=6)**	**Overall (*n*=36 to 40)**
Maintain SA	**6.0**	**6.0**	**5.7**	**6.0**
Workload				
Workload to maintain SA	**5.5**	**5.0**	**4.7**	**5.2**
Workload to plan mission	**4.4**	**4.8**	**5.0**	**4.6**
Workload to maneuver forces	**5.4**	**5.2**	**3.8**	**5.1**
Workload to control fires	**5.2**	**5.3**	**4.0**	**5.0**

SA; Diagonal = 1-4; Grey = 5-7; No Fill = 8-10
Workload; Diagonal = 8-10; Grey = 5-7; No Fill = 1-4

Table A-3. Visual display assessment

	Pilot (*n*=12)	**Trial 1 (*n*-6)**	**Trial 2 (*n*=9)**	**Overall (*n*=27)**
Intensity	**75**	**67**	**67**	**70**
Contrast between colors on screen	**100**	**88**	**67**	**85**
Sharpness of displayed images	**75**	**67**	**55**	**67**
Adjustability of viewing angle of monitor	**67**	**100**	**55**	**70**
Field of View of monitor	**75**	**100**	**77**	**82**
General resolution	**58**	**50**	**56**	**56**
Location of windows	**83**	**33**	**78**	**70**
Ease of finding cursor on screen	**92**	**60**	**89**	**85**

No fill = 75%-100% of respondents responding favorably
Grey = 50%-74% of respondents responding favorably
Diagonal = less than 50% of respondents responding favorably

Table A-4. Software functionality

Intuitiveness	**Pilot (*n*=12)**	**Trial 1(*n*-6)**	**Trial 2 (*n*=9)**	**Overall (*n*=27)**
Intuitiveness of window labels	**75**	**33**	**67**	**63**
Intuitiveness of processes or sequences	**82**	**17**	**56**	**50**
Logical sequences of performing functions on screen	**73**	**0**	**56**	**50**
Finding needed information	**55**	**0**	**50**	**40**
Intuitiveness of abbreviation, codes and acronyms used in applications	**64**	**0**	**44**	**42**
Logical sequences of performing functions on screen	**73**	**0**	**56**	**50**
Consistency (similar functions or sequences) from one application to another	**58**	**17**	**44**	**44**
Location of windows	**83**	**33**	**78**	**70**
Software Feedback	**Pilot (n=12)**	**Trial 1(*n*-6)**	**Trial 2 (*n*=9)**	**Overall (*n*=27)**
Feed back from applications (example-know that a message or map was sent and received)	**64**	**0**	**44**	**44**
Error recovery (know what problem is, how to fix or correct it) from applications	**64**	**0**	**50**	**46**
Applications showed attributes selected to help avoid mistakes (example highlighted selected data)	**50**	**0**	**57**	**42**
Audible alerts to recognize and correct mistakes in applications	**60**	**0**	**33**	**44**
Audible signals alerts to critical information	**50**	**0**	**33**	**38**
Visual alerts to critical information	**60**	**20**	**40**	**45**
Visual alerts to recognize and correct mistakes in applications	**60**	**20**	**40**	**45**
Applications prompts and helps	**55**	**0**	**50**	**43**
Application instructions and menu selections	**64**	**40**	**57**	**57**
Ability to tell if you have incoming critical information	**33**	**20**	**29**	**29**
Ability to tell if you have incoming information	**75**	**20**	**71**	**63**
Usability	**Pilot (*n*=12)**	**1st Trial (*n*-6)**	**2nd Trial (*n*=9)**	**Overall (*n*=27)**
Flexibility of automated tools	**75**	**17**	**67**	**59**
Usability of "hot keys" or short cuts in applications	**60**	**0**	**44**	**42**
Overall user friendliness of applications	**50**	**0**	**44**	**39**
Kill and re-start a process	**71**	**0**	**50**	**50**
Power up and log onto MC2	**64**	**50**	**83**	**67**

No fill = 75%-100% of respondents responding favorably
Grey = 50%-74% of respondents responding favorably
Diagonal = less than 50% of respondents responding favorably

Table A-5. Maps and graphics

Maps	**Pilot (*n*=12)**	**Trial 1(*n*=6)**	**Trial 2 (*n*=9)**	**Overall (*n*=27)**
Terrain feature size	**50**	**50**	**56**	**52**
Map tool functionality	**67**	**17**	**56**	**52**
Perform terrain analysis	**63**	**0**	**68**	**48**
Overlays	**Pilot (n=12)**	**Trial 1 (n-6)**	**Trial 2 (n=9)**	**Overall (n=27)**
Create an overlay	**43**	**40**	**75**	**55**
Display an overlay	**50**	**40**	**78**	**59**
Save an overlay	**100**	**50**	**89**	**85**
Import an overlay	**63**	**40**	**78**	**65**
Create and save an Area of Interest	**43**	**40**	**75**	**55**
Create and save a snapshot	**50**	**50**	**57**	**53**
Symbology	**Pilot (*n*=12)**	**Trial 1 (*n*=6)**	**Trial 2 (*n*=9)**	**Overall (*n*=27)**
Alphanumeric character size	**83**	**50**	**67**	**70**
Noncombatant symbology	**64**	**33**	**33**	**46**
Icon size	**92**	**33**	**44**	**63**
Edit overlay symbols	**57**	**20**	**75**	**55**
Unit symbol size	**75**	**50**	**67**	**67**
Unit identification	**58**	**17**	**67**	**52**
General symbol size	**75**	**33**	**44**	**56**
Unit boundaries and other control symbols	**50**	**17**	**44**	**41**
Change command relationship	**33**	**0**	**60**	**33**
Other	**Pilot (*n*=12)**	**Trial 1 (*n*=6)**	**Trial 2 (*n*=9)**	**Overall (*n*=27)**
Use animation tool	**43**	**20**	**75**	**50**
Operate a whiteboard	**50**	**0**	**67**	**36**

No fill = 75%-100% of respondents responding favorably
Grey = 50%-74% of respondents responding favorably
Diagonal = less than 50% of respondents responding favorably

Table A-6. Information management

Messaging	Pilot (*n*=12)	Trial 1(*n*=6)	Trial 2 (*n*=9)	Overall (*n*=27)
Create a message	63	20	71	55
Send a message	63	20	71	55
Access incoming messages	38	20	76	50
Create a distribution list	50	20	83	53
Ease of distribution outgoing information	46	17	57	42
Maintenance				
Copy and move files	50	25	86	59
Create directories	38	20	71	45
Create and display reports	14	0	57	29
Back up a database	60	0	67	42
Restore the data base in event of system crash	63	0	60	47
Create an OPORD	50	0	50	33
Interface with ABCS	50	0	67	40

No fill = 75%-100% of respondents responding favorably
Grey = 50%-74% of respondents responding favorably
Diagonal = less than 50% of respondents responding favorably

Table A-7. Frequency and ease of use of the following functions and applications

	Pilot (*n*=12)		Trial 1 (*n*=6)		Trial 2 (*n*=9)		Overall (*n*=27)	
Maps and Graphics	**Freq.**	**Ease**	**Freq.**	**Ease**	**Freq.**	**Ease**	**Freq.**	**Ease**
Maps and Overlays	90	40	60	60	56	78	71	58
Graphic Tool		38		25		75		50
Drawing Tool	50	43	0	25	67	68	48	55
MCOO	20	20	0	0	17	88	13	47
Line of Sight Tool	13	50	0	25	25	86	15	59
3D View Tool		60		25		75		54
Field of View Tool		50		25		71		53
Snapshot	25	60	0	0	33	83	24	57
Whiteboard	13	25	0	0	25	67	15	27
Information Management	**Freq.**	**Ease**	**Freq.**	**Ease**	**Freq.**	**Ease**	**Freq.**	**Ease**
Filters	29	60	25	0	43	67	33	50
Messaging	25	57	0	50	33	75	23	62
Help/Netscape	25	60	0	0	0	75	15	46
Microsoft Office	13	25	0	25	14	80	11	46
C2 Functions	**Freq.**	**Ease**	**Freq.**	**Ease**	**Freq.**	**Ease**	**Freq.**	**Ease**
Unit Task Organization	50	50	40	75	44	67	46	61
OPLAN/OPORD/Warning Order (WO)/ FRAGO	29	20	0	33	13	60	15	39
Synchronization Matrix	22	17	20	20	17	67	20	33
Force to Force Ratio	25	40	0	50	25	60	20	50
Animation System	25	50	0	50	33	87	21	61
C2 Products (UNIX File Manager)	14	33	25	25	17	86	18	53

No fill = 75%-100% of respondents responding favorably
Grey = 50%-74% of respondents responding favorably
Diagonal = less than 50% of respondents responding favorably

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Appendix B. Company and Platoon Level Functions and Workload Survey

1. Enter the last four digits of your SSN_____

2. Vignette

__ 1

__ 2

__ 3

3. Please indicate your position by putting an "x" in front of the appropriate position:

____ RSTA Company Commander

____ RSTA Executive Officer

____ RSTA Company Vehicle Commander

____ RSTA Platoon Leader

____ RSTA Platoon Vehicle Commander

____ MCS Company Commander

____MCS Platoon Leader

____ Infantry Platoon Leader

____ Infantry Platoon Sergeant

____ Robotics NCO

____ Infantry Squad Leader

____ Infantry Weapons Squad Leader

4. For the tasks listed below, indicate whether the interface performs the task automatically, assists you to perform it, or cannot be effectively performed with the interface. Put an "X" in the appropriate box.

Task	Performs Automatically	Assists Performance	Cannot Perform with Interface
Wargame COAs			
Identifies location of enemy unit			
Identifies type of enemy unit			
Identifies strength of enemy unit			
Projects future location of enemy unit			
Provides BDA on enemy unit			
Locates obstacles on terrain			
Identifies restricted, severely restricted, impossible terrain using MCOO			
Identifies effects of terrain on friendly maneuver			
Identifies location of friendly units			
Identifies type of friendly units			
Identifies strength of friendly units			
Projects future location of friendly units			
Provides projected attrition on friendly units			
Provides current logistical information			
Provides location of civilians on battlefield			
Provides strength of civilians on battlefield			

5. Following are tasks on which the interface can provide assistance in performing. Please rate the assistance provided on each task on the following scale.

Task	Very Poor	Poor	Borderline	Good	Very Good
Maintian Situational Awareness					
Access relevant information					
Develop plans collaboratively					
Develop OPORDs and create graphics					
Distribute OPORDs and graphics					
Rehearse the plan					
Maneuver forces					
Call for fires					
Control fires					
Notice changes in the situation in a timely manner					
Respond to changes in a timely manner					

6. Situational Awareness (SA): Rate your Situational Awareness (SA) during the vignette on the following scale:

	Far Too Low - Could not perform the task because I did not possess the neces-sary infor-mation	Extreme-ly Low – Unaware of almost all the informa-tion required to per-form the task	Very Low – Unaware of most of the informa-tion required to per-form the task	Low – Unaware of about half the informa-tion required to per-form the task	Reduced – Unaware of some important infor-mation required to per-form the task	Insuffi-cient – Not aware of all the infor-mation required to per-form the task	Not Com-plete – Able to perform the task but not satisfac-torily	Mostly Good- Able to perform the task well most of the time	Good – Able to perform task well all the time	Excellent – Able to perform task extremely well all the time
Over -all SA										

7. Workload: Rate your workload for the following tasks during the vignette on the following scale

Tasks	Work-load Insig-nifi-cant	Work-load Low	Enough spare capa-city for all desir-able addi-tional tasks	Insuffi-cient spare capacity for easy attention to addi-tional tasks	Reduced spare capacity – additional tasks cannot be given the desired amount of attention	Little spare capacity – level of effort allows little attention to addi-tional tasks	Very little spare capacity – but mainte-nance of effort in the pri-mary task not in question	Very high workload with almost no spare capacity – difficulty in main-taining level of effort	Extremely high workload – no spare capacity and difficulty in main-taining level of effort	Task aban-doned – unable to apply suffi-cient effort
Maintain SA										
Plan mission										
Maneuver forces										
Control fires										

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Appendix C. Visual Display Survey

1. Enter the last four digits of your SSN: _____

2. Vignette

   __1

   __2

   __3

3. Indicate your position by putting an "x" in front of the appropriate position:

   ____ RSTA Company Commander

   ____ RSTA Executive Officer

   ____ RSTA Company Vehicle Commander

   ____ RSTA Platoon Leader

   ____ RSTA Platoon Vehicle Commander

   ____ MCS Company Commander

   ____MCS Platoon Leader

   ____ Infantry Platoon Leader

   ____ Infantry Platoon Sergeant

   ____ Robotics NCO

   ____ Infantry Squad Leader

   ____ Infantry Weapons Squad Leader

4. Rate the following aspects of the visual display:

Visual Display Assessment

	Very Poor	Poor	Borderline	Good	Very Good	Not Applicable
Intensity (brightness/darkness) adjustment						
Contrast between colors on screen						
Sharpness of displayed images						
Adjustability of viewing angle of monitor						
Field of View of monitor						
Alphanumeric character size						
Terrain feature size						
Unit symbol size						
Unit identification						
Unit boundaries and other control symbols						
Noncombatant symbology						
General symbol size						
Icon size						
Unit boundaries and other control symbols						
Map tool functionality						
General resolution						
Intuitiveness of window labels						
Location of windows						
Finding cursor on screen						

5. Rate the following features:

	Very Poor	Poor	Borderline	Good	Very Good	Not Applicable
Flexibility of automated tools						
Logical sequences of performing functions on screen						
Intuitiveness of processes or sequences						
Consistency (similar functions or sequences) from one application to another						
Feed back from applications (example-know that a message or map was sent and received)						
Usability of "hot keys" or short cuts in applications						
Error recovery (know what problem is, how to fix or correct it) from applications						
Applications showed attributes selected to help avoid mistakes (example highlighted selected data)						
Audible alerts to recognize and correct mistakes in applications						
Audible signals alerts to critical information						
Visual alerts to critical information						
Visual alerts to recognize and correct mistakes in applications						
Applications prompts and helps						
Application instructions and menu selections						
Ease of finding cursor on screen						
Ability to tell if you have incoming information						
Ability to tell if you have incoming critical information						
Ease of distribution outgoing information						
Overall user friendliness of applications						
Finding needed information						
Intuitiveness of abbreviation, codes and acronyms used in applications						

5a. Overall, what percentage of time did you used the MC?

____ Percent

5b. Overall, what percentage of tiem did you use the SC4?

____ Percent

6. Rate the ease or difficulty of performing the following critical tasks using MC2:

	Very Hard	Hard	Borderline	Easy	Very Easy	Not Applicable
Power up and log onto MCS						
Create directories						
Copy and move files						
Create a distribution list						
Access incoming messages						
Create a message						
Send a message						
Create an overlay						
Display an overlay						
Create and save an Area of Interest						
Edit overlay symbols						
Import an overlay						
Save an overlay						
Perform terrain analysis						
Use animation tool						
Create and display reports						
Change command relationship						
Create and save a snapshot						
Create an OPORD						
Operate a whiteboard						
Back up a database						
Interface with ABCS						
Kill and re-start a process						
Restore the data base in event of a crash						

7. Rate the <u>frequency</u> of use of the following functions and applications in MC2:

	Never	Almost Never	Sometimes	Often	Always	Not Applicable
Unit Task Organization						
Messaging						
OPLAN/OPORD/Warning Order (WO)/ FRAGO						
Maps and Overlays						
Synchronization Matrix						
Briefing System						
MCOO						
C2 Products (UNIX File Manager)						
Help/Netscape						
Microsoft Office						
Line of Sight Tool						
Force to Force Ratio						
Snapshot						
Whiteboard						
Filters						
Graphic Tool (Maps & Overlays)						
Drawing Tool (Maps & Overlays)						

8. Rate the ease of use of the following functions and applications:

	Very Hard	Hard	Borderline	Easy	Very Easy	Not Applicable
Unit Task Organization						
Messaging						
OPLAN/OPORD/Warning Order (WO)/ FRAGO						
Maps and Overlays						
Synchronization Matrix						
Animation System						
MCOO						
C2 Products (UNIX File Manager)						
Help/Netscape						
Microsoft Office						
3D View Tool						
Line of Sight Tool						
Field of View Tool						
Force to Force Ratio						
Snapshot						
Whiteboard						
Filters						
Graphic Tool (Maps & Overlays)						
Drawing Tool (Maps & Overlays)						

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